Bulletin of Pure and Applied Sciences.
Botany, Vol.43 B, No.1.
January-June 2024: P.77-82
Review Article

Print version ISSN 0970 4612
Online version ISSN 2320 3196
DOI: https://doi.org/10.52710/bpas-bot.7
Available online at www.bpasjournals.com

A Review of the Use of Algae in Medicine

[1]Renu Rani* and [2]Sujata Rathi

Author's Affiliation
[1]Assistant Professor, Government Model Degree College, Kapoori Govindpur, Saharanpur, Uttar Pradesh 247665, India
[2]Assistant Professor, Department of Botany, Multanimal Modi College, Modinagar, Ghaziabad, Uttar Pradesh 201204, India

***Corresponding Author:**
Renu Rani
Assistant Professor, Government Model Degree College, Kapoori Govindpur, Saharanpur, Uttar Pradesh 247665, India
E-mail: Renu31panwar@gmail.com

Keywords:
Algae,
Antidiabetic activity,
Antioxidant activity,
Antiviral activity.

Received on 12.02.2024
Revised on 28.04.2024
Accepted on 12.05.2024

Abstract
The most significant producers of food on Earth are primarily algae. Their impact on the environment goes far beyond photosynthesis. Due to the wide variety of substrates and stressors they encounter, including extremophilic settings, they produce a huge variety of chemicals. The major goal of this study is to collect data on pharmacological, therapeutic, and biochemical applications and how they affect human welfare. Comparatively speaking to foods from the terrestrial realm, algae have higher concentrations of vital vitamins, minerals, proteins, lipids, polysaccharides, and enzymes. Algae are utilised in a number of different ways, including as a preventative, sources of vitamins, as a source of cancer fighting and tumour fighting agents, anti-coagulants and anti-thrombic agents, sources of anti-inflammatory substance, antibiotic's source, sources of antiviral substance, dietry supplements, nutra-ceuticals, vermifuges, sources of bio-cosmetics, in thalasso-therapy, in obstetrical uses, etc.

How to cite this article: Rani R. and Rathi S. (2024). A Review of the Use of Algae in Medicine. *Bulletin of Pure and Applied Sciences-Botany,* 43B (1), 77-82.

1. INTRODUCTION

The only thalloid phototrophic organisms that never develop embryos are algae (as well as their colourless descendants). Different types of algae comprise pond scum, seaweed, freshwater and marine phytoplankton, etc. Marine algae have long been exploited in conventional and alternative medicine (Keshri & Mukhopadhyay, 2012), but it wasn't until 1950 that scientists realized how useful they may be in modern medicine (Lincoln *et al*., 1991). The utilisation of micro-algae in this context is relatively recent and represents an attractive area of study. Since algae are a significant source of vitamins, minerals, anti-oxidants, and natural colorants, adding the entire biomass to food and feed could be utilized to add colour, increase nutritional value, and enhance texture or oxidation resistance. Marine algae like *Sargassum siliquastrum, Ishige okamurae* are UV protectors and used in cosmetics. *Ulva rigida, Gracilaria verrucosa, Sargassum vulgare, Cystoseira barbata* and *Dictyopteris membranacea* are used in Thalassitherapy of skin. *Sargassum siliquastrum, Gelidium amansii, Dictyota dichotoma, Laminaria ochotensis, Polysiphonia japonica* & *Ecklonia cava* inhibit melanin synthesis. There are following advantage of using Algae as a food and medicine supplements-

- Algae grow fast
- Algae consumes CO_2
- Algae do not compete with agriculture
- Can be grown in the Sea.

2. ANTIOXIDANT PROPERTIES OF ALGAE

In the final stages of the development of cancer, antioxidants are crucial. The most potent antioxidants that are found in several groups of algae include polyphenols, phycobili-proteins, and vitamins. These anti-oxidant substances aid in the remission of precancerous lesions and prevent the transformation of those lesions into cancer. It has been found that a number of algae species have inhibited the growth of cancer cells by scavenging reactive oxygen free radicals, hence preventing oxidative damage. Combating against several diseases (such as cancer, chronic inflammation, atherosclerosis, and cardiovascular ailments) and ageing processes relies heavily on antioxidants. Several types of algae naturally produce enormous quantities of carotenoids such -carotene, asta-xanthin, and cantha-xanthin (Borowitzka, 1988). *Dunaliella salina*, a green salt loving flagellate acquires over ten percent of its dry weight in the form of -carotene, which is used for commercial purposes in various countries (Borowitzka and Borowitzka 1988). The antioxidant activity of astaxanthin is greater than that of β-carotene & α-tocopherol (Miki, 1991). Although astaxanthin is now chemically synthesized for commercial purposes, researchers are constantly looking for sources of astaxanthin in nature due to the adverse effects of artificial substances (Liu and Lee, 2000). Both *in vitro* and *in vivo* experiments show that the sulphated polysaccharide, which was derived from sea algae, has free radical scavenging properties. In rats with liver injuries, a low molecular weight sulfated polysaccharide (LMWF) from *Laminaria japonica* that has a molecular weight of 8–10 KDalton has demonstrated both hepatoprotective and antioxidant properties (Zhao, *et al*., 2004). Phlorotannins (polyphenols) present in marine flora are thought to have anti-oxidant properties. Brown seaweed produces a special class of polyphenol derivatives called phlorotannins, which are biosynthesized by the acetate malonate pathway and are bioactive metabolites.

Table 1: antioxidant activity of compounds isolated from Algae

S. No.	Bioactive compound	Algae	Activity
1.	Astaxanthin	Microalgae	Extremely Potent scavenger of ROS. Improve serum lipid profile by normalizing serum triglycerides. Improve integrity of mitochondrial membrane by preventing oxidative damage
2.	Phlorotannins	Brown seaweeds	Inhibit Reactive Oxygen species Inhibit thiobarbituric acid reactive species
3.	Sulfated Polysacharides	Brown and Red sea weeds	Having immense antioxidant potential. Ferrous ion chelating activities.

3. ANTICANCER ACTIVITY OF ALGAE

Due to their extensive range of biological activities against a large range of viral, fungal bacterial allergies and oxidizing agents, marine seaweeds are among the most fascinating groups of algae. To defend themselves from biotic and abiotic stress, seaweeds generate an array of bioactive substances in their environment. Preliminary studies have indicated that a naturally non-toxic substance (-carotene) extracted from algae may be helpful in the treatment of pre-cancerous disorders such oral leukoplakia, which is probably a precursor to oral cancer. In the Chinese medicine system, tinctures from *Sargassum* and *Laminaria* species have been used in the regression of cancer (Yamamoto *et al*., 1974). Human nasopharyngeal and colorectal cancer cells can be effectively destroyed by the cytotoxic indole (Palermo, *et al*., 1992 derivatives Chondriamide A and B, which were isolated from the red alga *Chondria* *atropurpurea.* The Kahalalide F (a marine algae derived cyclic depspeptide) isolated from *Bryopsis* has been found to be effective against cancer and tumour causing agents by altering function of lysosomal membranes (Hamann and Scheuer, 1993; Hamann, *et al.*, 1996). Due to the process of gathering samples of marine florals, the development of marine floral chemicals as therapeutative agents is still in its infancy. Pharmaceutical firms as well as academic institutions have invested a lot of time and energy in the search for novel marine-derived natural compounds, particularly those generated from algae species.

4. ANTIVIRAL PROPERTIES OF ALGAE

Even while vaccines are very effective at controlling many viral diseases, some illnesses are still resistant to treatment. Researchers looked at the possibility that some mutant, resistant antiviral medicines developed with significant adverse effects and failed to treat latent infections. The idea of antiviral molecules with medicinal benefit was not readily accepted due to the toxicity of many of the earlier antiviral medicines. In order to separate medicinal compounds from plants, scientists are always interested. Several sulfated polysaccharides that have been extracted from seaweeds have antiviral properties (De Clercq, 2000). Dextran sulfate, pentosan polysulfate and heparin have been set up effective as anti-HIV agents (Witvrouw and De Clercq, 1997). Sulfated galactan from *Aghardhiella tenera* and sulfated xylomannan from the red seaweed *Nothogenia fastigata* has set up to be a potent source against HIV- 1, HIV-2, mortal cytomegalovirus(HCMV), respiratory syncytial contagion (RSV), and influenza A contagion by targeting on HepG2 cell lines(Witvrouw, *et al.*, 1994).The activity of reverse transcriptase has been shown to be inhibited *in vitro* by a sulfated polysaccharide from *Schizymenia pacifica* (Nakashima, *et al.*, 1987a, 1987b, even with the first viral attachment to the host cell has been shown to be inhibited by galactan sulphate from *Gracilaria corticata* (Mazumdar, *et al*., 2002). However, due to their low oral absorption (Witvrouw, *et al.*, 1994), sulfated polysaccharides' application in medicine is currently restricted. Additionally, their effectiveness when administered parenterally has not yet been proven. Carrageenans have been shown to have antiviral activity in vitro and to be effective against a variety of HSV strains during the viral adsorption stage. Fucoidan another polysaccharide from brown algae is prove to a potent inhibitor for binding and internalization of enveloped virus (Malhotra, *et al*., 2003, Sugawara, *et al.*, 1989), and a category of non-enveloped virus (Baba, *et al.*, 1988).

Table 2: Antiviral activity of compounds derived from algae

S. No.	Bioactive compound	Algae	Mode of action
1.	Carrageenan	Red algae	Inhibitory effect involved in the attachment or internalization of enveloped and non-enveloped virus into target cell
2.	Galactan	Red algae	Inhibitory effect involved in the attachment of virus into host cell
3.	Fucan and Fucoidan	Brown Algae	By halting the activity of Reverse Transcriptase.
4.	Laminarin	Brown algae	Adsorption of HIV on human derived lymphocyte Blocking of HIV reverse transcriptase.
5.	Alginates	Brown algae	Inhibit viral replication by significantly diminishing the activity of reverse transcriptase.
6.	Naviculan	Diatoms	Blocking viral internalization into the target host cell.
7.	pKGo3	Marine algae	Viral adsorption and internalization step
8.	Calcium spirulan	Marine BGA	Inhibition of virus entry into the host cell. Anticoagulant activity. Suppression of syncytium formation.

5. ANTIDIABETIC ACTIVITY

Research on marine algae's ability to prevent diabetes has shown promising potential in managing diabetes and related conditions. Marine algae, also known as seaweeds are abundant in bioactive compounds like polysaccharides, polyphenols, peptides and pigments that exhibit various biological activities including anti diabetic activity. Studies have indicated that certain marine algae extracts can help in regulating blood glucose level by enhancing insulin sensitivity, inhibiting carbohydrate digesting enzymes and improving glucose uptake by cells. In comparison to other common medications, an aqueous extract of *Ulva fasciata* showed a good and notable change in blood glucose and glycosylated haemoglobin levels when administered to diabetic rats (Abirami, 2013). The Angiotensin-converting enzyme inhibitory impacts of phlorotannins isolated from the brown macro-alga *Ecklonia cava* were described (Wijesinghe and Jeon, 2011). Angiotensin I and II converting enzymes, which are an integral part of the renin-angiotensin system, can lower blood pressure by regulating the body's fluid content.

6. ALGAE IN FOOD AND COSMETICS

Algae have garnered significant attention in both the food and cosmetic industries due to their rich nutrient profile and diverse applications. In food research algae such as *Spirulina* and *Chlorella*, are explored for their high protein content, essential fatty acids, vitamins and minerals. They offer a sustainable source of nutrition and being incorporated into various food products like energy bars, smoothies and even meat substitutes. Similarly in cosmetics realms, algae's potential is being harnessed for its natural pigments, antioxidants and moisturizing properties. Algal extracts are used in skincare products for their capacity to hydrate, rejuvenate and shield the skin from environmental stress (Joshi *et al.*, 2018). Moreover, algae derived materials are being investigated for potential anti-ageing and anti-inflammatory effects, making them promising ingredients for the cosmetic industry. Algal extracts and oils are incorporated into skincare and haircare products for their moisturizing and soothing effects. As research continues to unveil the benefit of algae, their utilization in food and cosmetics is likely to expand, promoting sustainable and innovative product development. PUFAs are nutritionally & pharmaceutically valuable products that produce mainly by marine micro algae.

7. DIAGNOSTIC AND THERAPEUTIC AGENTS

Biosensors based on algae are being developed to detect different kinds of biomolecules and contaminants in the environment. This biosensor has applications in environmental monitoring and medical diagnostics. More research is being done on algae-based nanoparticles as a medicine delivery mechanism. Pharmaceutical substances can be encapsulated in these nanoparticles and delivered to particular bodily locations. It is possible to engineer algae, especially microalgae, to manufacture recombinant proteins, such as antigens for the creation of vaccines. This strategy provides a scalable and economical way to produce vaccines. Additionally, chemicals derived from algae have demonstrated immuno-modulatory activities that affect the immune response. The creation of immunotherapies and the management of autoimmune disorders are both impacted by this characteristic. Research on the biotechnological use of algae in medicine is still underway and is a rapidly developing topic.

8. CONCLUSION

A thorough analysis of several literary works from both India and the outside world was done for this review section. The use of marine algae from ancient times to the present is thoroughly studied in this essay. Antioxidants, vitamin sources, tumor-fighting agents, antibiotics, antiviral compounds, bio-cosmetics, nutritional supplements, vermifuges, sedatives,wound healing compounds, thirst quenchers, remedies for arthritis, gallstones, goitre, arterial hypertension, stools, bowel movements, gastroenteritis, burns, ulcers, dermatological conditions, lung diseases, and semen discharge are all possible uses for algae.

Despite the fact that marine algae and its products have many uses in the pharmaceutical, clinical, and industrial sectors, regularly consuming them may be unsafe as it may be polluted with heavy metals. The maritime environment provides an ideal habitat for the development of novel compounds with diverse biological properties that can combat a wide range of biotic and abiotic stress. The bioactive carbon and nitrogen containing secondary metabolites (phenolic compounds, glycosides, alkaloids, and active metabolites linked to insecticides) found in red and brown seaweeds, including steroids are thought to have tremendous medical significance. Because they have no adverse effects compared to allopathic pharmaceuticals, we can thus employ these herbal plants and their compounds to treat a variety of disorders. The role of algae in medicine continues to evolve with ongoing research, presenting a wealth of opportunities to harness their bioactive compounds for improved healthcare outcomes. Further studies and advancements in the field are likely to uncover additional applications and deepen our understanding of the therapeutic potential of algae.

REFERENCES

1. Abirami R G and Kowsalya S. (2013). Antidiabetic activity of *Ulva fasciata* and its impact on carbohydrate enzymes in alloxan induced diabetic in rats. International Journal of Research in Phytochemistry & pharmacology, 3(3), 136-141.
2. Ahmadi, A., Zorofchian Moghadamtousi S., Abubakar, S., zandi, K. (2015). Antiviral potential of algae polysaccharides isolated from marine resources: A review. Biomed Res.Int. 2015, 825203. Doi: 10.1155/2015/825203.Epub 2015 sep 21. PMID: 26484353; PMCID: PMC4592888.
3. Baba, M., Snoeck, R., Pauweb, R. and De Clerq, E. (1988). Sulfated polysaccharides are potent and selective inhibitors of varius enveloped viruses, including herpes simplx virus, cytomegalovirus, vesicular stromatitis virus, and human immunodeficiency virus. Antimicrob. Agents Chemother., 32, 1742-1745.
4. Barsanti, L. and Gualtieri, P. (2006). Algae: Anatomy, Biochemistry, and Biotechnology. Taylor & Francis. Boca Raton, USA. 301pp.
5. Borowizka, M. A. (1988). Fats oils and hydrocarbons. In: Micro-algal Biotechnology. M. A. Borowizka, and L. J. Borowizka, eds., Cambridge University Press, Cambridge, pp. 257-287.
6. Damonte, E., Neyts, J., Pujol, C. A., Snoeck, R., Andrei, G., Ikeda, S., Witvrouw, M., Reymen, D., Haines, H., Matulewicz, M. C., Cerezo, A., Coto, C. and De Clercq, E. (1994). Antiviral activity of a sulphated polysaccharide from the red seaweed *Nothogenia fastigata.* Biochem. Pharmacol., 47, 2187-2192.
7. DeClercq, E. (2000). Current lead natural products for Chemotherapy of human immunodeficiency virus (HIV) infection. Med. Res. Rev., 20, 323-349.
8. Feldman, S. C., Reynaldi, S., Stortz, C. A., Cerezo, A. S. and Damont, F. B. (1999). Antiviral properties of fucoidan fractions from *Leathesia difformis*. Phytomed, 6, 335-340.
9. Graham, L. E., Graham, J. M. and Wilcox, L. W. (2009). Algae (2nd Ed.). Benjamin Cummings.
10. Hamann, M. T. and Scheuer, P. J. (1993). Kahalalide F: A bioactive depsipeptide from sacoglossan mollusk, *Elysia rufescens* and the green alga *Bryopsis* sp. J. Am.Chem. Soc., 115, 5825-5826.
11. Joshi, S., Kumari, R., and Upasani, V. N. (2018). Applications of Alga in cosmetic: An Overview. International Journal of Innovative research in Science, Engineering and Technology, 7(2), 1269-1278.
12. Keshri, J. P., Mukhopadhyay, R. (2012). Algae in medicine. Medicinal plants: various perspectives. Pub. Department or Boatany and Publication Unit, The University of Burdwan, pp.31-50.
13. Lincoln, R. A., Struinski, K. and Walker, J. M. (1991). Bioactive compounds from algae. Life Chem. Rep., 8, 97-183.
14. Liu, B. H. and Lee, Y. K. (2000). Secondary carotenoids formation by the green alga *Chlorococcum* sp. J. appl. Phycol., 12, 301-307.
15. Malhotra, R., Ward, M., Bright, H., Priest, R., Foster, M.R., Hurle, M., Blair, E. and Bird, M. (2003). Isolation and characterisation of potential respiratory syncytial virus receptor(s) on epithelian cells. Microbes Infect, 5, 123-133.

16. Mazumdar, S. Ghosal, P. K., Pujol, C. A., Carlucci, M. J., Damonte, E. B. and Ray, B. (2002). Isolation, chemical investigation and antiviral activity of polysaccharides from *Gracilaria corticata* (Gracilariaceae, Rhodophyta). Int. J. biol. Macromol, 31, 87-95.

17. Miki, W. (1991). Biological function and activity of animal carotenoides. Pure appl. Chem., 63, 141-146.

18. Palermo, J. A., Flower, B. P. and Seldes, A. M. (1992). Chondriamides A and B, new indolic metabolites from the red alga *Chondria* sp. Tetrahedron Lett., 33, 3097-3100.

19. Ponce, N. M. A., Pujol, C. A., Damonte, E. B., Flores, M. L. and Stortz, C. A. (2003). Fucoidans from the brown seaweed: *Adenocystis utricularis*: extract methods, antiviral activity and structural studies. Carbhyd. Res., 338, 153-165.

20. Sugawara, I., Itoh, W., Kimura, S. Mori, S. and Shimada, K. (1989). Further characterization of sulfated homopolysaccharides as anti-HIV agents. Experientia, 45, 996-998.

21. Wijesinghe, W.A.J.P.,Jeon, Y-J. (2011). Biological activities and potential cosmeceutical applications of bioactive components from brown seaweeds: A Review. Phytochemistry Reviews, 10(3), 431-443.

22. Witvrouw, M. and De Clercq, E. (1997). Sulphated polysaccharides extracted from sea algae as potential antiviral drugs. Gen. Pharmac., 29, 497-511.

23. Witvrouw, M., Desmyter, J. and De Clercq, E. (1994). Antiviral portrait series: 4. Polysulphates as inhibitrs of HIV and other enveloped viruses. Antiviral Chem. Chemother., 5, 345-359.

24. Yamamoto, I., Nagumo, T., Yagi, T., Tominaga, H. and Aoki, M. (1974). Antitumor effectsof seaweeds I. Antitumor effect of extracts from *Sargassum* and *Laminaria*. Japan J. Exp. Med., 44, 543-546.

25. Zhao, X., Xue, C. H., Li., Z. J., Cai, Y. P., Liu, H. Y. and Qi, H. T. (2004). Antioxidant and hepatoprotective activity of low molecular weight sulfated polysaccharide from *Laminaria japonica*. J. Appl. Phycol., 16, 111-115.

****